

DRAWINGS

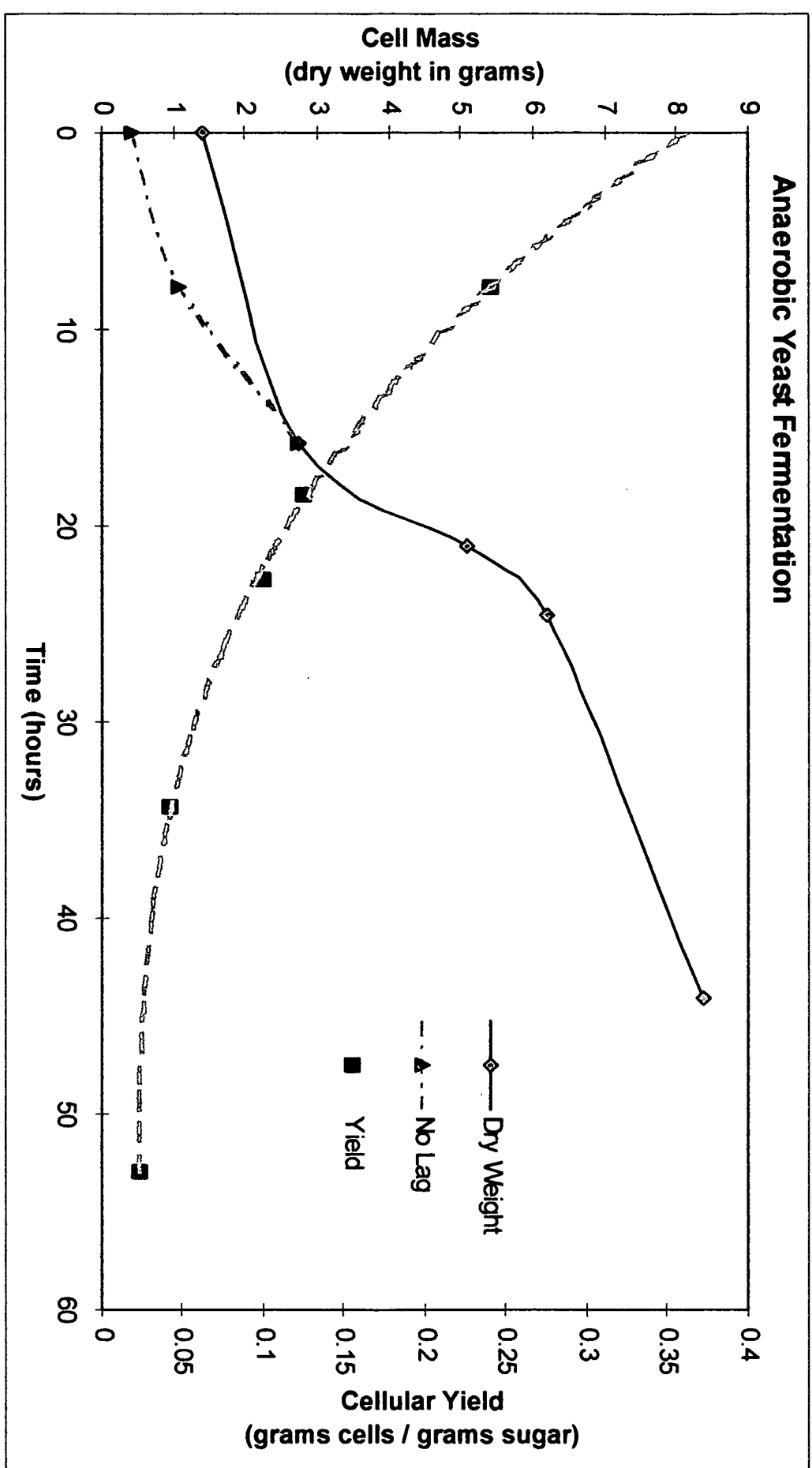
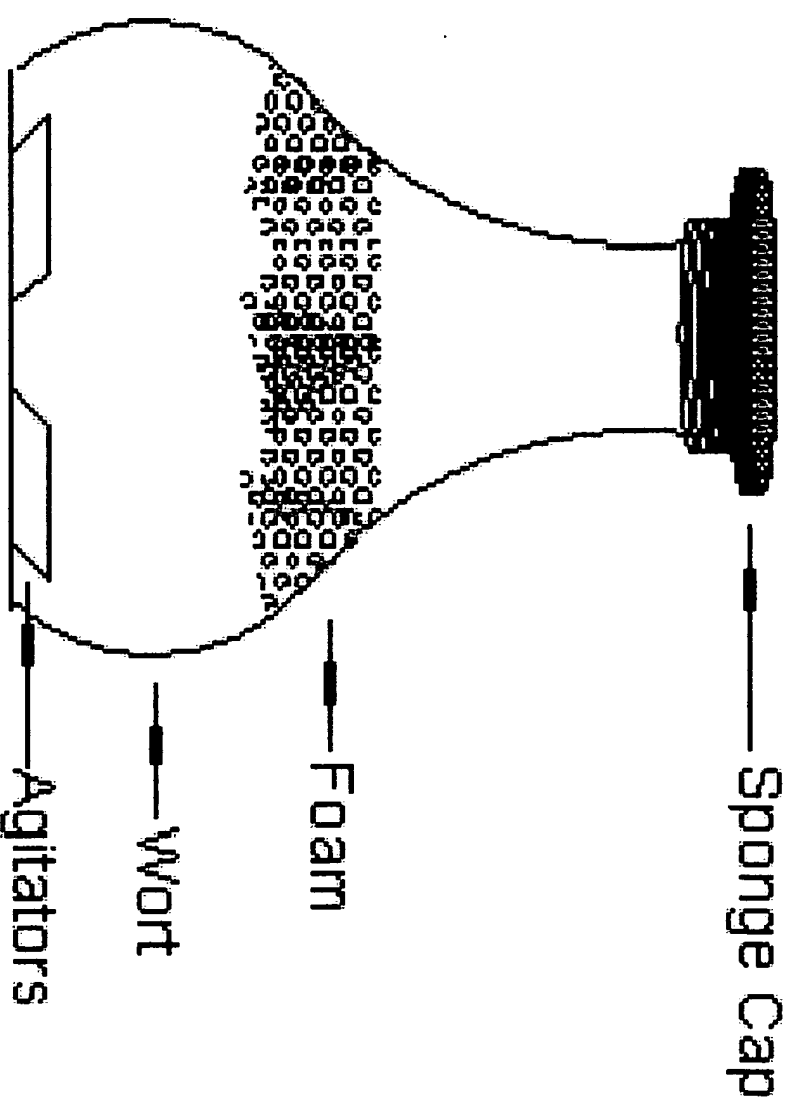


Figure 1



2 liter Fernbach Flask

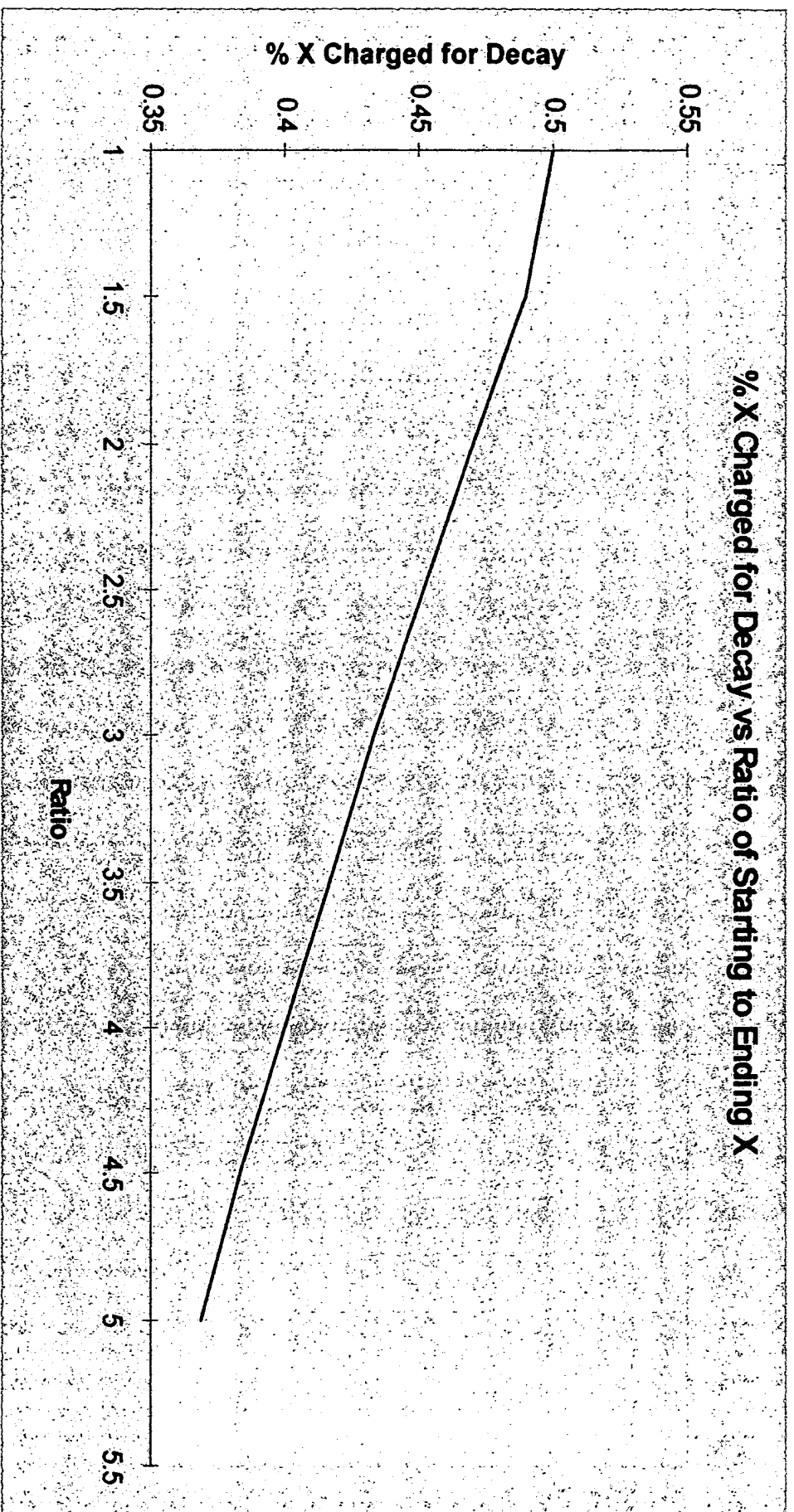
Oxygen transfer is limited by the small surface area on the top, and the foam that forms.

Figure 2

Time During Fermentation	Yield (g cells/ g sugar)	Ammonia Needed (grams)	Water Produced (grams)	CO ₂ Produced (liters)	Yeast Produced (C ₅ H ₁₀ O ₃ N) (grams dry wt.)	Ethanol Produced (C ₂ H ₆ O) (grams)*
1st 3rd	.15	18.70	5.1	22.51	15.04	41.19
2nd 3rd	.052	.65	1.79	25.54	5.20	47.68
3rd 3rd	.023	.29	.79	26.44	2.30	49.61
Overall	.05	.626	1.72	25.60	5.00	48.52

* For ethanol volume, divide weight (in grams) by its' density (0.789 grams/ml)

Table 1

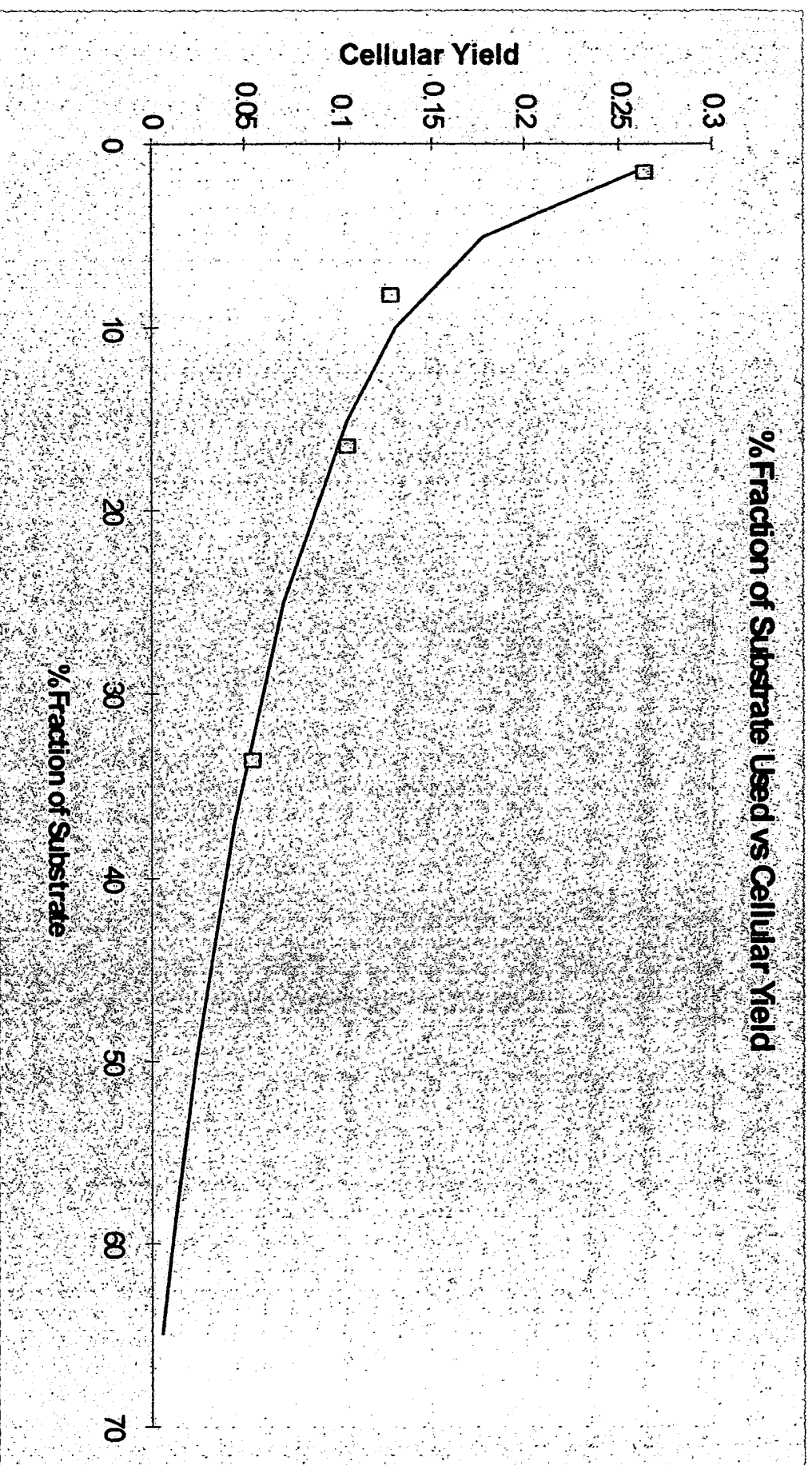


EQXchrgd **Xchrgd = 0.504076447609 ×**
EXP(- 0.0816252748703 × Ratio)

Figure 3 / Equation 10

Sample Name	Time (hours)	X weight (grams)	S.G. Reading (g S/l, see EQSG)	Measured CO2 Flow (ml / min)
t ₀	0	1.415	183.59	0
t ₁	15.75	2.73	178.11	3.944
t ₂	21.03	5.1	158.94	12.344
t ₃	24.5	6.18	147.99	15.074
t ₄	44.08	8.38	95.965	7.234

Table 2



Comparison of the four data points with the yield curve (EQ%used)
 $Y = -6.67814305038 \times 10^{-2} \times [\ln(\%used)] + 0.284841059276$
log fit; $r^2 : -.9924$

Figure 4

b=.004/hr

Test Fermentation Data

A	B	C	D	E	F	G
Interval	Observed New X	Total hours of interval	Mass lost from starting X decay	Sub-total new mass (B + D)	Ratio new X/Start X (Starting X + E) / Starting X	Change what new mass b?
t ₀ - t ₁	1.315	15.75	0.089145	1.404145	1.9923	0.471
t ₁ - t ₂	2.37	5.28	0.0576576	2.4276576	1.88925	0.475
t ₂ - t ₃	1.08	3.2	0.06528	1.14528	1.22457	0.5
t ₃ - t ₄	2.2	19.58	0.4840176	2.6840176	1.434307	0.493

A	H	I	J	K	L	M
Interval	Decay of new mass (E x G x C x .004)	Total new mass yield (E + H)	Amount of sugar used (g/l)	Average % S consumed	Yield g X / g S	Yield (fm curve) g X / g S
t ₀ - t ₁	0.0416652	1.4458102	5.48	1.4925	0.263833977	0.258098264
t ₁ - t ₂	0.024354261	2.45201186	19.17	8.206	0.127908809	0.144275124
t ₂ - t ₃	0.007329792	1.152609792	10.95	16.409	0.105261168	0.097997972
t ₃ - t ₄	0.103634643	2.7876522	52.025	33.56	0.053582936	0.05021553
						97.83%
						112.80%
						93.10%
						93.72%

Table 3

Evaluation of Test Fermentation

Interval	% fraction of S	Yield fm EQ%used	Ratio fm EQYld (l CO ₂ /g X)	Total new X (grams)
t ₀ - t ₁	1.4925	0.2580973	0.79324921	1.445803
t ₁ - t ₂	8.206	0.14427497	1.52663404	2.452006
t ₂ - t ₃	16.409	0.097998	2.3594534	1.1526299
t ₃ - t ₄	33.56	0.0502161	5.00801093	2.787623

Interval	liters CO ₂ predicted fm model (g X x Ratio)	liters CO ₂ predicted by actual Yield	Average measured CO ₂ (ml / min)	liters CO ₂ predicted fm avg of measured CO ₂ flow rate at this interval
t ₀ - t ₁	1.1469	1.1192	1.972	1.8635
t ₁ - t ₂	3.7433	4.2872	8.144	2.58
t ₂ - t ₃	2.71968	2.5095	13.709	2.6321
t ₃ - t ₄	13.9604	12.9849	11.154	13.1037

Table 4